

**UNITED STATES PATENT APPLICATION**

**OF**

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**FOR**

**METHOD OF MILLING ENGINE BLOCKS**

**Attorney Docket No. 024444-983**

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## METHOD OF MILLING ENGINE BLOCKS

### FIELD OF THE INVENTION

[0001] The present invention relates to high speed milling of engine blocks comprising aluminum and cast iron. More particularly, the present invention relates to a method of high speed milling of engine blocks.

### BACKGROUND OF THE INVENTION

[0002] In the description of the background of the present invention that follows reference is made to certain structures and methods, however, such references should not necessarily be construed as an admission that these structures and methods qualify as prior art under the applicable statutory provisions. Applicants reserve the right to demonstrate that any of the referenced subject matter does not constitute prior art with regard to the present invention.

[0003] Modern engine blocks for passenger cars are often made of aluminum with cast iron liners. For the machining of these coated cemented carbides and Polycrystalline Diamond (PCD) inserts are generally used. Coated carbides can not be used at cutting speeds above 600 m/min and higher due to too high thermal load. PCD inserts function well but are not competitive due to high cost. Wet milling is used due to surface finish and chip evacuation. Emulsions used in machining are environmental and health problems and lead to a higher cost. Cutting data are;

Cutting speed approximately 150-300 m/min and feed-rate/tooth around 0.15-0.30 mm/tooth. Depth of cut is between 0.2 and 1.5 mm.

[0004] In general engine blocks are produced in transfer lines and the time pressure is high. Often this operation is a bottleneck in the production. Milling cutters with close pitch are used which leads to change of about 30-40 inserts when they are worn out. One typical wear mechanism is built up edge which leads to a bad surface finish and failure of the cutting edge which leads to rapid wear. The main reason for tool change is surface finish and demands are high which leads to frequent tool changes.

[0005] Silicon nitride is a cutting tool material for machining of cast iron due to its good wear resistance and good high temperature properties. The properties of silicon nitride are greatly dependent on the density, and it has been found necessary to add sintering aids to silicon nitride in order to fully densify the body. Typically the sintering aids used are  $\text{Al}_2\text{O}_3$ ,  $\text{BeO}$ ,  $\text{MgO}$ ,  $\text{TiO}_2$ ,  $\text{ZrO}_2$ ,  $\text{HfO}_2$  and the oxides of the Group III elements of the periodic table scandium, yttrium, lanthanum, cerium, etc. The amount of sintering aid added is of the order of a few wt-%. The sintering aids form during sintering a glass phase, which facilitates the densification. Silicon nitride cutting inserts thus consist of beta silicon nitride in an intergranular glass phase.

[0006] It is an extremely high demand to develop tool solutions with a long tool life and less frequent tool changes. Dry machining of these type of applications is a strong demand in order to reduce costs, health hazards and environmental impacts.

#### SUMMARY OF THE INVENTION

[0007] A method of milling a material provides a silicon nitride based cutting tool insert, cuts at a cutting speed of 1000-3000 m/min, and feeds at a feeding rate of 0.05-0.5 mm/tooth to a cutting depth of 0.2-2 mm. The cutting tool insert has a chip thickness of 0.09-0.17 mm. The material milled can comprise aluminum and cast iron.

#### DETAILED DESCRIPTION OF THE INVENTION

[0008] It has now surprisingly been found that by dry machining using silicon nitride inserts at a cutting speed above 1000 m/min a longer tool life and increased productivity can be achieved. The problem with built up edge and wear disappeared surprisingly with these cutting data using silicon nitride inserts. The problems with built up edge remained with silicon nitride inserts in lower cutting speeds and the wear was also higher.

[0009] The present invention relates to machining of composite materials (aluminum in combination with cast iron) using silicon nitride inserts.

The cutting data is as follows:

Cutting speed = 1000-3000, preferably 1100-2500m/min;

Cutting feed/tooth = 0.05-0.5, preferably 0.15-0.30 mm;

Cutting depth = 0.2-2 mm, preferably 0.3-1 mm; and

Chip thickness = 0.09-0.17 mm.

[0010] Example: Face milling of engine block was performed under the following conditions:

Operation: Face milling, finishing

Work piece: Engine block

Material: Aluminum 8% Si and pearlitic grey cast iron

Cutting speed: See table

Feed rate/tooth: 0.26 mm

Depth of cut: 0.5 mm

Insert style: 28 pcs SBEX1203ZZ-11 and 4 pcs SBEN1203ZZ

Grade 1: Coromant grade 6090

Grade 2: WC-6% Co cemented carbide with 4  $\mu$ m TiN+TiC-coating

Milling cutter: Auto FS 260.42 of diameter 250 mm

[0011] Result: Tool life/insert is shown in the table. The tool life criterion was unacceptable surface finish including component frittering. The following results were obtained:

| Tool life/insert |                   |                   |
|------------------|-------------------|-------------------|
| Cutting Speed    | Grade 1 Invention | Grade 2 Reference |
| 444 m/min        | 10 pcs            | 22 pcs            |
| 1178 m/min       | 60 pcs            | not possible      |
| 2356 m/min       | 70 pcs            | not possible      |

[0012] With silicon nitride inserts a higher productivity and a longer tool life can be achieved, which can reduce problems, such as bottlenecks in the production and less frequent changes of tools. Another advantage is the ability to turn off coolant, which has environmental as well as cost advantages.

[0013] While the present invention has been described by reference to the above-mentioned embodiments, certain modifications and variations will be evident to those of ordinary skill in the art. Therefore, the present invention is to limited only by the scope and spirit of the appended claims.